Communication System, Communication Unit And Method Of Power Saving Therein

Field of the Invention

5

This invention relates to power saving in a communication unit operating in a communication system. The invention is applicable to, but not limited to saving processing power in the management of radio link admission control

10 and/or scheduling, and/or overload or flow control, in a wireless communication system.

Background of the Invention

15 Wireless communication systems, for example cellular telephony or private mobile radio communication systems, typically provide for radio telecommunication links to be arranged between a plurality of base transceiver stations (BTSs) and a plurality of subscriber units, often termed

20 mobile stations (MSs). Base station contollers (BSCs) are provided, each BSC controlling one or more BTS.

Wireless communication systems are distinguished over fixed communication systems, such as the public switched

25 telephone network (PSTN), principally in that mobile stations move between BTS (and/or different service providers) and in doing so encounter varying radio propagation environments.

30 In a wireless communication system, each BTS has associated with it a particular geographical coverage area (or cell). A particular range defines the coverage area where the BTS can maintain acceptable communications

with MSs operating within its serving cell. Often these cells combine to produce an extensive coverage area.

Present day communications systems, both wireless and
5   wire-line, have a requirement to transfer data between communications units. Data, in this context, includes speech communication. Such data transfer needs to be effectively and efficiently provided for, in order to optimise use of limited communication resources.
10

One such wireless communication system is the third generation partnership project (3GPP) standard supporting wide-band code-division multiple access (WCDMA) relating to the Universal mobile telecommunication system (UMTS)
15   radio access network (RAN) known as UTRAN. The European Telecommunications Standards Institute (ETSI) is defining the 3GPP standard.

Within UMTS nomenclature, the base transceiver station
20   (BTS) is called a node B, and a base station controller (BSC) is called a radio network controller (RNC).

Within the UTRAN, many communication resources need to be managed effectively, for example:
25

        (i) The air interface (i.e. CDMA power and code) resource, with separate air interface resources for, say, each cell.
        (ii) The backhaul resource supporting, for
30   example limited capacity E1 links, with separate resources for, say, each Node B.
        (iii) Node B hardware/software resources, for example managing the Node B's processing capability (e.g.

as defined by the microprocessors, back-plane networking, etc.), may limit the throughput of data that is achievable within a cell.

(iv) RNC Hardware/software resources.

5

In some conventional systems, the same (or at least a similar) set of QoS management algorithms must be applied to each resource. These QoS management algorithms include:

10

(i) Admission control: performed when a new call enters the system/cell. Admission control has an objective of determining whether QoS will be maintained for all connections, if the new call is admitted.

15 (ii) Scheduling: performed every frame. Scheduling has an objective of ensuring that the number of data packets submitted for transmission will not exceed the capacity available over a short time period, such as a 10 msec. frame.

20 (iii) Overload control: used if the aforementioned admission control and/or scheduling mechanisms fail in their function, in order to rectify the situation. Actions might include 'call pre-emption' in which low priority calls are thrown off the system.

25 (iv) Flow control: This could be considered a sub-category of overload control, and is at least related to overload control. Flow control causes the source rate to be decreased in order that the system does not become congested.

30

Running all four of these QoS control mechanisms, for each of the many UTRAN resources, consumes a significant amount of processing power in terms of mega instructions

per second (MIPS). The processing impact is felt principally in the radio network controller (RNC) in the 3GPP system, but also in the Node B.

5 The inventors of the present invention have recognised and appreciated that current QoS management algorithms address all resources with equal regard. Hence, there is no consideration as to their relative importance in limiting the data throughput of the network. It is

10 possible that in some, perhaps even most, instances, a few of the UTRAN resources will be over-dimensioned with respect to the others. For these (relatively speaking) over-dimensioned resources, the MIPS consumed in performing the QoS management functions will be wasted,

15 since other resources will represent a bottleneck in limiting a data throughput performance.

Thus, there exists a need in the field of this invention, to provide an improved QoS management methodology,

20 particularly in cellular base-site resources in a wireless communication system (where transmission delay is a constraint), wherein the abovementioned disadvantages may be alleviated.

25 Statement of Invention

In accordance with a first aspect of the present invention, there is provided a communication system, as claimed in Claim 1.

30

In accordance with a second aspect of the present invention, there is provided a method of reducing power

consumption in a system management function (e.g. an RNC) in a communication system, as claimed in Claim 15.

In accordance with a third aspect of the present invention, there is provided a 3GPP wireless communication system, as claimed in Claim 23.

In accordance with a fourth aspect of the present invention, there is provided a radio network controller, as claimed in Claim 24.

In accordance with a fifth aspect of the present invention, there is provided a storage medium, as claimed in Claim 25.

In accordance with a sixth aspect of the present invention there is provided a radio network controller, as claimed in Claim 26.

The inventive concepts of the present invention provide a mechanism for identifying the bottleneck resources in a wireless communication system. In this regard, the provision and management of access to the resources is focused on primarily the bottleneck resources. Management of other resources can be adapted accordingly, such that processing power (in terms of MIPS) can be saved. When applied to a 3GPP system, processing power in an RNC (and, to a lesser extent, a Node B) can be saved, such that the RNC (and/or Node B) could be designed to operate more efficiently and effectively. In this manner, the improved RNC (and/or Node B) is able to serve the same number of Erlangs as a similar element in

a conventional system, but for less cost due to the
reduced processing capabilities required.

In summary, the inventive concepts of the present
5   invention provide a mechanism for identifying a resource
bottleneck in a communication system. Additionally, the
inventive concepts propose a mechanism for prioritising
management algorithms to focus primarily on the
bottleneck resource. Once access to the bottleneck
10   resource performance has been managed, a reduced (if any)
level of management algorithm MIPS is applied to other
resources. Thus, by circumventing management of
resources when no benefit can be gained due to the
bottleneck limitations incurred by another resource,
15   processing power can be saved.

Brief Description of the Drawings

Exemplary embodiments of the present invention will now
20   be described, with reference to the accompanying
drawings, in which:

FIG. 1 illustrates a schematic diagram of an example of a
throughput capability of each of the UTRAN resources,
25   determined and responded to according to a preferred
embodiment of the present invention;

FIG. 2 shows a block diagram of a 3GPP cellular radio
communications system adapted to support the various
30   inventive concepts of a preferred embodiment of the
present invention;

FIG. 3 illustrates a flowchart of a scheduler scheduling data packets for transmission dependent upon a number of resources used in the transmission in accordance with the inventive concepts of a preferred embodiment of the

5 present invention; and

FIG. 4 illustrates a flowchart of admission control for transmission of data packets dependent upon a number of resources used in the transmission according to a

10 preferred embodiment of the present invention.

Description of Preferred Embodiments

In the context of the present invention, any reference to

15 power saving should be viewed as encompassing saving of processor resources, for example in terms of mega instructions per second (MIPS).

The preferred embodiments of the present invention

20 selectively apply QoS algorithms to one or more system resources, but notably not all system resources to the same degree. The preferred application of the present invention is a 3GPP wireless communication system architecture. In this regard, the present invention

25 introduces a concept of an 'active set'. The 'active set' is a list of the bottleneck UTRAN resources for which a substantial number, and preferably all, QoS management algorithms will be run. The QoS management algorithms in this context preferably comprise:

30 scheduling and admission control.

In summary, the inventive concepts of the present invention provide a mechanism for identifying a resource

bottleneck in a communication system. A mechanism for
prioritising the QoS management algorithms is proposed,
to focus on the bottleneck resource. Once the bottleneck
resource performance has been optimised, a reduced (if

5   any) level of management is applied to the other
resources. By avoiding running management algorithms for
resources when no benefit can be gained due to the
bottleneck limitations incurred by another resource,
processing power can be saved.

10

Referring now to FIG. 1, a schematic diagram 100
illustrates a throughput capability of each of the UTRAN
resources. In this illustration, the throughout of each
resource may be visualised as a pipe of a given size. In

15   the illustration of FIG. 1, the I_{ub}/I_{ur} backhaul resource
115 is clearly the bottleneck in the delivery of
communication services as this resource has the smallest
diameter (data throughput) pipe, when compared to the RNC
or Node B hardware/software resource 105, 110, or the

20   air-interface resource 120.

In accordance with the preferred embodiments of the
present invention, once the 'bottleneck' has been
identified, the efficiency improvement algorithms such as

25   running admission control and scheduling algorithms are
applied to this 'bottleneck' resource alone. In this
manner, the 'system' is able to save on its processing
requirements, when compared to current systems, and still
provide the same level of service.

30

Referring now to FIG. 2, a cellular-based telephone
communication system 210 supporting a Universal Mobile
Telecommunications Standard (UMTS) air-interface is

illustrated, in outline, in accordance with a preferred embodiment of the invention. In particular, the described embodiment relates to the Third Generation Partnership Project (3GPP) specification for wide-band

5   code-division multiple access (WCDMA) standard relating to UTRAN.

A plurality of subscriber units 212-216 communicates over the selected air-interface 218-221 with a plurality of

10   Node Bs 222-232. A limited number of subscriber units 212-216 and Node Bs 222-232 are shown for clarity purposes only. Each Node B 222-232 contains one or more transceiver units and communicates with the rest of the cellular system infrastructure via I_{ub} interface 235. The

15   Node Bs 222-232 may be connected to external networks, for example, the public-switched telephone network (PSTN) or the Internet 234 through Radio Network Controller stations (RNC) 236-240 and any number of mobile switching centres (MSCs) 242 and Serving GPRS Support Nodes (SGSN)

20   244.

Each RNC 236-240 may control one or more Node Bs 222-232. Each MSC 242 (only one shown for clarity purposes) provides a gateway to the external network 234, whilst

25   the SGSN 244 links to external packet data networks.

The Operations and Management Centre (OMC) 246 is operably connected to RNCs 236-240 and Node Bs 222-232 (shown only with respect to Node B 226 and Node B 228 for

30   clarity), and administers and manages functions within the cellular telephone communication system 210, as will be understood by those skilled in the art.

In accordance with a preferred embodiment of the present invention, one or more RNCs 236-240 has been adapted to include a bottleneck detector function. The functionality of the bottleneck detector function is

5 described below, particularly with regard to the decision process of adding an identified bottleneck resource to an 'active set', or removing an identified bottleneck resource from an 'active set'.

10 In addition, a scheduler typically run in the one or more RNCs 236-240 to schedule the transmission of data packets has also been adapted. The scheduler is operably coupled to the bottleneck detector function and has been adapted to schedule data packets according to a determined

15 prioritisation. In particular, the data packets are scheduled according to whether a bottleneck resource, as identified by the RNC, will allow the data packet to pass therethrough.

20 Furthermore, in the preferred embodiment of the present invention, an admission control function/algorithm typically run in the one or more RNCs 236-240 has also been adapted. The admission control function/algorithm is operably coupled to the bottleneck detector function

25 and has been adapted to admit a user requesting access according to a determined prioritisation. In particular, the admission control function/algorithm is based on whether a bottleneck resource, as identified by the RNC, will support the transmissions of the requesting user.

30

More generally, one or more RNCs effectively perform an improved system management function, where the RNCs are programmed, in any suitable manner, according to the

preferred embodiment of the present invention. For
example, new apparatus may be added to a conventional
communication unit (for example RNC 236). Alternatively
existing parts of a conventional communication unit may

5   be adapted, for example, by reprogramming one or more
processors therein. As such the required adaptation (to
introduce a bottleneck detector or adapt a scheduler
and/or an admission control function) may be implemented
in the form of processor-implementable instructions

10   stored on a storage medium, such as a floppy disk, hard
disk, programmable read only memory (PROM), random access
memory (RAM) or any combination of these or other storage
media.

15   Although the preferred embodiment of the present
invention is described with reference to a bottleneck
detector and improvements to the efficient usage of, say,
one or more QoS management algorithms such as a scheduler
and/or an admission control function/algorithm relating

20   to an RNC's operation, it is envisaged that these
functions/algorithms may reside in other network
elements. For example, it is envisaged that the
inventive concepts in adapting the system's performance
in response to a detected bottleneck resource may be

25   implemented daily or weekly. In this regard, the
aforementioned functions/algorithms may be located in,
say, the OMC 246, in contrast to the dynamic adaptation
provided when the aforementioned functions/algorithms are
preferably located in the RNC.

30
It is also within the contemplation of the invention that
such aforementioned functions/algorithms may reside in
other network elements, or alternatively be distributed

amongst two or more such network elements in wireless communication systems. Furthermore, alternative radio communication architectures could benefit from the inventive concepts described herein, and the inventive

5   concepts are not considered as being limited to the specific configuration illustrated in FIG. 2.

In a first embodiment of the present invention, the 'active set' is configured to include all UTRAN

10 resources. The QoS algorithms are optimised to exploit the findings of the bottleneck detector in the RNC. In this first embodiment, all resources are considered within the 'active set'. The RNC determines the likelihood of each resource being a data throughput

15 bottleneck, which limits the data throughput performance of the system. The determination is preferably made using one of the following measurements, which are further described later:

      (i) The frequency at which the overload control

20 function is initiated; or

      (ii) Through measurements of the percentage utilisation of the resource.

Let us now consider how the respective QoS mechanisms

25 have been adapted to support the inventive concepts of the present invention.

Scheduler algorithm

30 In the preferred embodiment of the present invention, the scheduler algorithm in the UTRAN runs, for example, every radio frame and schedules all the queued data packets for transmission in the next frame.

A known scheduler operation takes a data packet at a head of a data queue and determines, in a serial, per-data packet manner, whether the introduction of that data

5 packet will overload any of a number of resources. All resources are checked in the known scheduler operation, with equal importance allocated to the resources. The resources could be, for example, code consumption, power consumption, backhaul bit-rate consumption, etc.

10

If the scheduler determines that the introduction of the data packet will overload a particular resource, the scheduler terminates the scheduling operation. Alternatively, the scheduler operation is terminated when

15 the data packet queue is exhausted.

A problem with this known approach is that unnecessary checks are made for every data packet, checking per-data packet consumption for each and every resource. The

20 inventors of the present invention have identified this as wasteful, particularly in scenarios where the resource is plentiful. For example, a downlink scheduler may be code limited, i.e. it stops scheduling when the code resource is exhausted. When the scheduler stops, the

25 power and backhaul utilisation may be very low, say at 50%, but a determination has been made as to the consumption of these resources for every data packet scheduled. Thus, this adds unnecessary loading onto the scheduler processor.

30

The improved scheduler operation, adapted in accordance with a preferred embodiment of the present invention, is illustrated in the flowchart 300 of FIG. 3. First, the

RNC identifies a primary bottleneck resource, for example resource 'A', in step 302. Then, the scheduler operation commences by taking a data packet at the head of a queued data stream, as shown in step 305.

5

In the preferred embodiment of the present invention, a determination is first made as to the resource that is most likely to limit the data packet throughput, i.e. the resource that would *typically* reach 100% utilisation before the others. Thus, this (bottleneck) resource is

10 allocated the highest priority in the scheduling determination process. The limitation imposed by the bottleneck resource, termed resource 'A', is determined in step 310. Notably, the scheduler assesses the impact of each received data packet **only** against this resource

15 'A', as data packets are added to the schedule, as in step 315. This process of introducing further data packets from the queue is continued until resource 'A' is fully utilised.

20

Thereafter, once resource 'A' is exhausted, the process checks the consumption of the second resource, 'B', as shown in step 320. It is expected that resource 'B' would be the next highest priority resource, i.e. the

25 second worst bottleneck identified from the number of resources. Resource 'B' is therefore likely operating below full utilisation at this point, as resource 'A' is typically the limiting resource. However, this relationship may not necessarily be true, so preferably

30 the remaining resources are checked. If resource 'B' is fully utilised, data packets are removed from the schedule, in step 325 until the utilisation of resource

'B' <=100%.   Notably, consumption of resource 'A' will
now be <100%.

In an enhanced embodiment of the present invention, an
5   intelligent decision is made as to which data packet(s)
is/are removed from the schedule.   In this context, it is
envisaged that it would be better to remove data packets
that have the greatest use of resource 'B'.   For example,
if resource 'B' is backhaul bandwidth, the data packets
10   that consume the greatest size (in bits) are removed from
the schedule.

This process continues, as shown for example in steps
330, 335, taking the next highest priority resource until
15   a schedule is found for which all resources are at <=
100% usage.   The scheduler process is then complete, as
shown in step 345.

It is clear that the above scheduling algorithm may
20   involve as few as 1/n process steps of the known
consumption-checking algorithm, where n is the number of
resources to be checked.   Furthermore, as shown in the
mapping table, the bottleneck detector has employed, in
step 340, a 'mean utilisation' as a metric to
25   order/prioritise the respective resources.   In this
manner, the bottleneck resource is the resource that has
the highest percentage mean utilisation.   It is envisaged
that in other embodiments a peak or a variable or fixed
percentile loading could be used.
30

Admission control algorithm

Admission control is a process for determining whether,
or not, resources are to be granted to a requesting
communication device. Inefficient operation of admission
control is possible when the admission control algorithm

5   does not examine, in an optimum sequence, the admission
request against the resources that are currently
available. A preferred mechanism for implementing
admission control is illustrated in the flowchart 400 of
FIG. 4.

10

The preferred mechanism commences in step 402 with the
RNC identifying resource 'A' as a primary bottleneck
resource. The RNC receives a request, in step 405, of a
call admission attempt. A determination is then made as

15   to whether the admission of the call requires allocation
of resource; say resource 'A' in step 410, which is
greater than the available capacity of resource 'A'. If
the requested amount of resource 'A' is greater than the
capacity of resource 'A' the call is not admitted, as

20   shown in step 430. Resource 'A' has been previously
identified by the RNC as being the likely bottleneck
resource in terms of data throughput. Consequently,
resource 'A' is allocated the highest priority in the
admission control process.

25

If resource 'A' has sufficient capacity to accommodate
the call in step 410, a determination is made as to
whether the requirements of a second resource, say
resource 'B' in step 415, is greater than the capacity

30   provided by resource 'B'. If the requested amount of
second resource 'B' is greater than the available
capacity of resource 'B', the call is not admitted, as
shown in step 430.

Similarly, if resource 'B' has sufficient capacity to accommodate the call in step 415, a determination is made as to whether the requirements of a third resource, say

5   resource 'C' in step 420, is greater than the available capacity of resource 'C'. If the requested amount of resource 'C' is greater than the available capacity provided by resource 'C' the call is not admitted, as shown in step 430. This process continues until all

10 resources have been checked, at which time the call is admitted, as shown in step 425.

In accordance with the preferred embodiment of the present invention, a tracking process is introduced to

15 count a failure rate of admission attempts for a particular resource. If the proportion of admission failures on a certain resource, compared to the total number of admission requests as measured over some preceding time interval, exceeds a given threshold, then

20 the resource should be moved further up the list of resources to be checked. In this manner, the resource will be checked earlier in future. Furthermore, in the same manner as the above scheduling operation, the resources 'A', 'B' and 'C' (and any others) are

25 prioritised in an order of the likelihood of an admission failure. This ordering process is preferably based on the failure count statistics.

In this manner, the number of checks required for a call

30 admission attempt that will ultimately fail is minimised, i.e. the ordering of the resource checks has been configured such that the admission control process would likely fail at the first step of checking resource 'A'.

Advantageously, this algorithm delivers a significant benefit during periods of high load, when blocking is occurring regularly and when the RNC processors are already under a heavy load stress.

5

In accordance with a second embodiment of the present invention, the active set is deemed a subset of the UTRAN resources. In this context, the reduction in MIPS is achieved by performing QoS management only on those

10 resources in the active set, i.e. the one or more resources that have been identified as bottleneck UTRAN resources. It is noteworthy that, in the second embodiment, overload detection and reaction mechanisms are in place for all UTRAN resources and will be in an

15 'active' operational mode all of the time.

Also, in this second embodiment, the active set of UTRAN resources most preferably is configured to be adaptable in that the resources could be dynamically added to, or

20 removed from, the active set. Preferably, at cell set-up (i.e. Node B power on) all UTRAN resources will be configured to be in the active set.

Thereafter, it is envisaged that a UTRAN resource will be

25 added to the active set list if, over some preceding time interval or over some preceding number of scheduling/ admission control events, one or more overload alarms were raised corresponding to that particular UTRAN resource.

30

In a similar manner, it is envisaged that a UTRAN resource will be removed from the active set if a limitation due to that particular resource has NOT been

logged as one of the reasons that prevented a packet to be scheduled, or a call to be admitted. Again, this determination is carried out over some preceding time interval or over some preceding number of scheduling

5 and/or admission control events. In addition, it is preferred that at least one UTRAN resource remains in the 'active set' list. In this case, for the one remaining UTRAN resource in the active set list, all the relevant QoS mechanisms (admission control, scheduling, flow

10 control, overload control) will be applied.

Table 1: Indication of UTRAN resources versus QoS algorithm for one 'active set'

UTRAN resource	UTRAN resource in active set?	Perform admission control for the resource?	Perform scheduling for the resource?	Perform flow control for the resource?
RNC hardware/ software	Yes	Yes	Yes	Yes
Backhaul resource (Iub, Node B #1)	Yes	Yes	Yes	Yes
Backhaul resource (Iub, Node B #2)	No	No	No	No
Backhaul resource (Iur, RNC n – RNC p)	Yes	Yes	Yes	Yes
Backhaul resource (Iur, RNC n – RNC q)	No	No	No	No
Node B hardware / software (Node B#1)	No	No	No	No
Node B hardware / software (Node B#2)	Yes	Yes	Yes	Yes
Air interface resource (Cell #1)	Yes	Yes	Yes	Yes
Air interface resource (Cell #2)	No	No	No	No

If a UTRAN resource is in the active set then all QoS management functions are run. Note that in a practical system there will be many more UTRAN resources than the limited number shown in Table 1.

In an enhanced feature of the second embodiment of the present invention, an active set is associated with each of the QoS management mechanisms: admission control, scheduling. The particular QoS mechanism is 'run' only

for those UTRAN resources in the active set. Preferably,
each QoS management mechanism is configured to operate on
their respective timescale, for example:

5   (i) An admission control function may be
configured to manage an average number of resources on a
relatively long time scale (say, in terms of seconds),
whereas
          (ii) A scheduler may manage schedule resources on
10   a shorter timescale (say, of the order of 10 msec).

It is also envisaged that different overload control
mechanisms can be triggered over different timescales.
In the case of some resources (in this example we will
15   consider the air interface), the notional resource pipe
size may be subject to relatively large fluctuations on a
short timescale, whilst being reasonably constant over a
longer timescale. Hence, for example, it might be
important to perform air interface scheduling, whilst it
20   might not be necessary to perform air interface admission
control.

Table 2: Indication of UTRAN resources versus QoS algorithm with one 'active set' per QoS algorithm

UTRAN resource	UTRAN resources in "admission control" active set	UTRAN resources in "scheduling" active set	UTRAN resources in "flow control" active set
RNC hardware/ software	Yes	Yes	Yes
Backhaul resource	Yes	Yes	No
Node B hardware / software	No	Yes	No
Air interface resource	No	No	No

5   Table 2 indicates three active sets for this enhancement to the second embodiment, one for each QoS mechanism. Again, in a practical system, there will be many more UTRAN resources than the limited number shown in Table 2.

10   Alternatively, one could define the set of QoS mechanisms that manages resources on a given timescale. Then, for each timescale, it is possible to define the UTRAN resources for which the applicable QoS mechanisms will be applied, as shown below in Table 3.

15

Table: 3 Indication of UTRAN resources versus QoS algorithm with timer implications

UTRAN resource	UTRAN resources in "10 ms QoS mgmt timescale" active set scheduling applied	UTRAN resources in "100 ms QoS mgmt timescale" active set flow control applied	UTRAN resources in a 1 sec. QoS mgmt timescale active set. Admission control/ overload control applied
RNC hardware/ software	Yes	Yes	Yes
Backhaul resource	Yes	Yes	No
Node B hardware / software	No	Yes	No
Air interface resource	No	No	No

5   Table 3 illustrates three active sets, one for each QoS management timescale, where different QoS mechanisms are applied for each timescale.

In this enhancement of the second embodiment, it is
10   envisaged that a UTRAN resource may be added to the active set list, for a QoS mechanism/ QoS management timescale, if an overload control alarm is triggered for that resource. The measurement is preferably performed over the corresponding QoS management time period.
15   Similarly, a UTRAN resource may be removed from the active set list for a given QoS mechanism/ QoS management timescale if a limitation in the resource has NOT been logged as one of the reasons that prevented a packet to be scheduled or a call to be admitted. Again, it is
20   envisaged that this determination is performed over some preceding time interval or over some preceding number of scheduling and/or admission control events.

Furthermore, the above mechanisms for adding resources to, or removing resources from, the active list would require that there had been no overload alarm raised
5　corresponding to that particular UTRAN resource over the preceding time interval or number of scheduling and/or admission control events. In addition, it is preferred that at least one UTRAN resource remains in the 'active set' list, for that QoS management mechanism or the QoS
10　management mechanism timescale.

In a yet further enhancement of the second embodiment, it is envisaged that reliance on overload control alarm triggering as a mechanism for modifying the active set
15　could be reduced or removed. The alternative approach could be to perform regular measurements of the loading on each of the resources, and to make add or drop decisions on the basis of the current loading. Such a mechanism will beneficially reduce the (unwanted)
20　occurrence of overload.

For simplicity reasons only, let us consider a case where there is just one active set. At cell set-up (i.e. Node B power on), all UTRAN resources will be in the active
25　set. Regular measurements of the load on each of the UTRAN resources are then performed. It is envisaged that the load measurement could be averaged or could, for example, be the xth percentile. Either way, in this example, measures of load would be expressed as a
30　percentage of the total UTRAN resource capacity.

Thus, a UTRAN resource will be removed from the active set if, for example, the UTRAN resource load is less

than, say, Threshold_1 and has been for some time period T_1. Furthermore, a UTRAN resource will be added to the active set list if, for example, the UTRAN resource load is greater than, say, Threshold_2, and has been for some

5   time period T_2.

It is also within the contemplation of the present invention that any combination of the above inventive concepts could be employed. For example, it is envisaged

10   that there could be an active set per QoS mechanism or per QoS mechanism timescale. In this regard, say at regular intervals, the particular loading as measured over certain timescales (e.g. 10, 100 or 1000 msec's) is determined for all UTRAN resources. If a certain loading

15   criteria (threshold) is met, then a UTRAN resource will be added to, or removed from, the active set list.

Furthermore, it is envisaged that whenever an overload on a resource is identified, the resource could be

20   immediately added to the active set.

It is also within the contemplation of the present invention that a decision on the specific QoS management mechanisms to apply for a given resource could be made

25   'off-line'. In this context, the decision may be encoded as an OMC parameter. Off-line dimensioning calculations and/or experience through trial and error and/or expert systems could be used to as part of this process.

30   Although the preferred embodiment of the present invention has been described with reference to a bottleneck identifier in the context of a UTRAN 3GPP system, it is envisaged that the inventive concepts are

equally applicable to other telecommunication systems,
wireless or wire line, including for example core
networks or backbone networks.

5   For completeness, it is worth clarifying how the reduced
complexity (power in terms of MIPS) requirement may be
exploited in practice. However, a skilled artisan would.
appreciate that the inventive concepts described herein
can be exploited in a number of other ways, and therefore
10   the inventive concepts are not limited to the mechanisms
described below.

When a wireless communication network is currently
installed, it is necessary that an RNC has a processing
15   capability approximately equal to that deemed necessary
to support the worst-case scenario. In this regard, the
RNC needs to be configured sufficiently to accommodate
all UTRAN resources. This typically results in some
inefficiency on initial network installation, since it is
20   to be expected that typically the RNC would be under-
utilised in some respects. Furthermore, as the network
load increases and more Node Bs are added, the
inefficiencies of the RNC processor increase.

25   Therefore, it will be understood that the improved QoS
management methodology where the bottleneck detection
algorithm is running, as described above, provides at
least the following advantages:

        (i)   Decisions on whether to add additional RNC
30   processor resource can be taken at the OMC by monitoring
the load on the RNC's processor resource.

(ii) The rate at which RNC cards would have to be added in order to support a higher network load would be reduced.

(iii) Where some of the QoS processing is
5 performed in the Node B (e.g. hardware/software admission control), the technique will also result in a reduction in signalling and call set-up delays on the occasions where the Node B hardware/software resource is not a bottleneck resource.
10

Whilst the specific and preferred implementations of the embodiments of the present invention are described above, it is clear that one skilled in the art could readily apply variations and modifications to the preferred
15 embodiments that fall within the inventive concepts.

Thus, a communication system and method for reducing power consumption in a communication system have been provided wherein the aforementioned disadvantages of the
20 prior art have been substantially alleviated.